
# Crypto-Trading

## Rechargeable token-based smart energy market enabled by blockchain and IoT technology

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# Summary

The Crypto-Trading Project

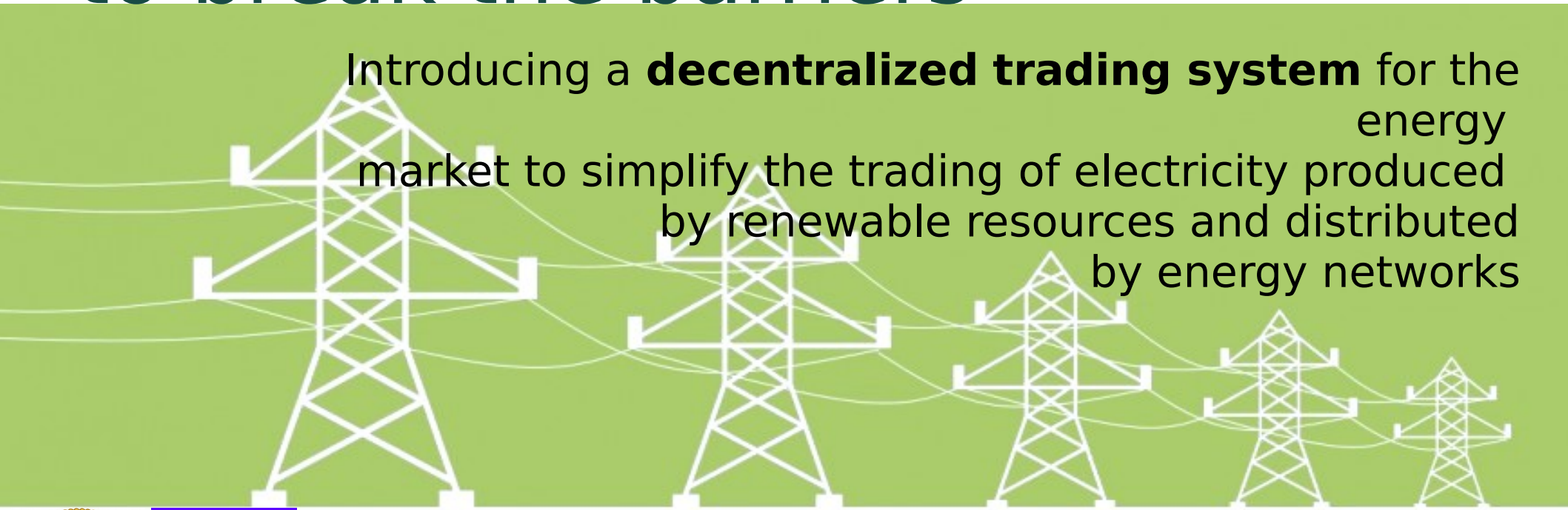
System design

System details

Token Implementation

# The Crypto-Trading project

# The Crypto-Trading project: to break the barriers



Introducing a **decentralized trading system** for the energy market to simplify the trading of electricity produced by renewable resources and distributed by energy networks

SELFIEWEALTH

SMART SPECIALISATION STRATEGY
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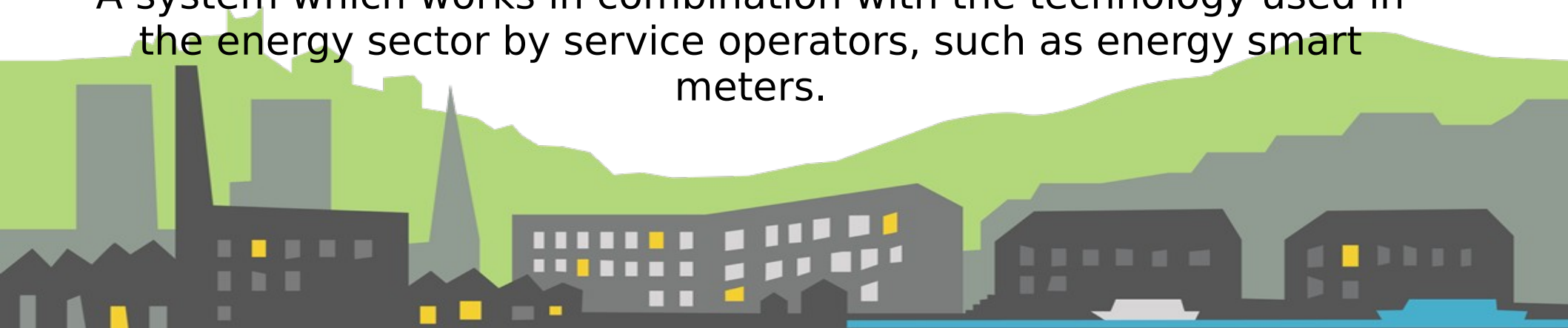
# Crypto-Trading is:

A new typology of free and decentralized energy market,  based on the **blockchain technology** and enable by a trading platform

A blockchain oriented software system compatible with the existent product of the
Internet of Things technologies

A system which works in combination with the technology used in the energy sector by service operators, such as energy smart meters.



# Crytpo-Trading technology

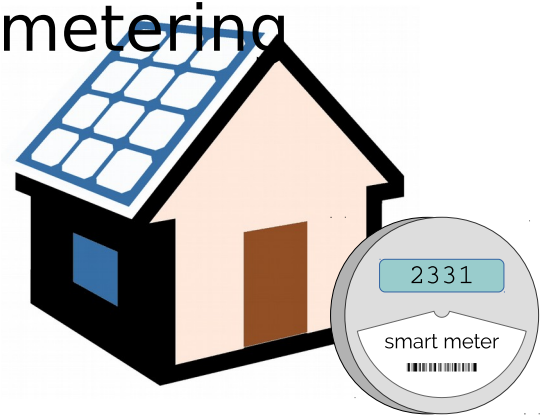
blockchain

IoT

trading platform

# C-T system overview

## Smart metering

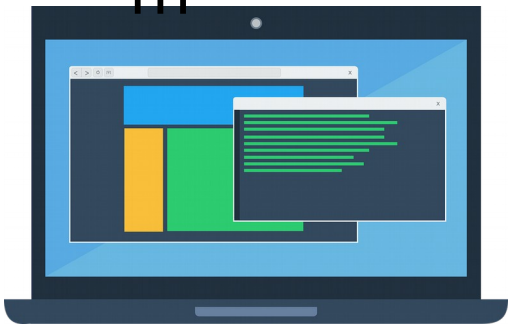



Energy sources
smart meters
final users

## blockchain

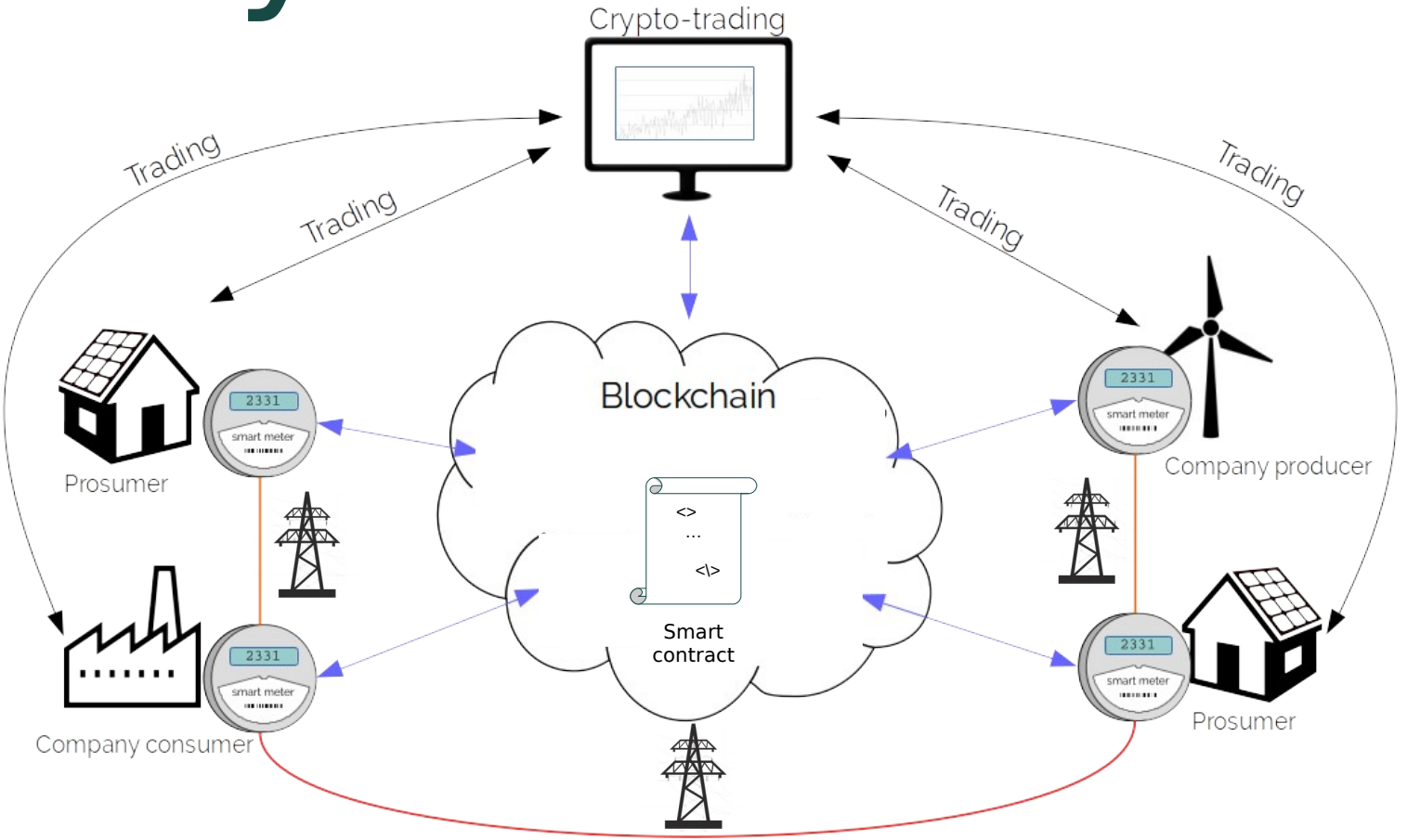
Energy Ledger
Smart contracts
Energy token

## platform

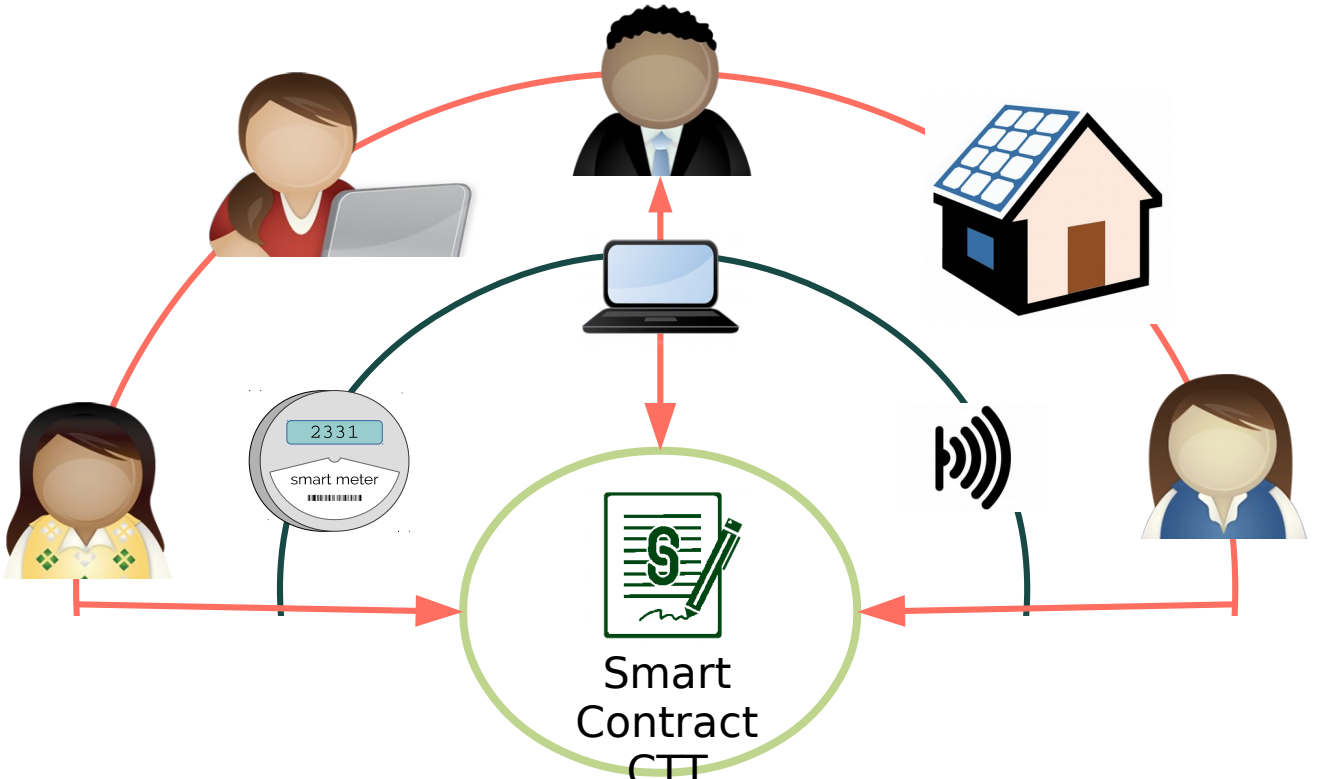


Energy Trading
Robot advisor
Provide suggestions

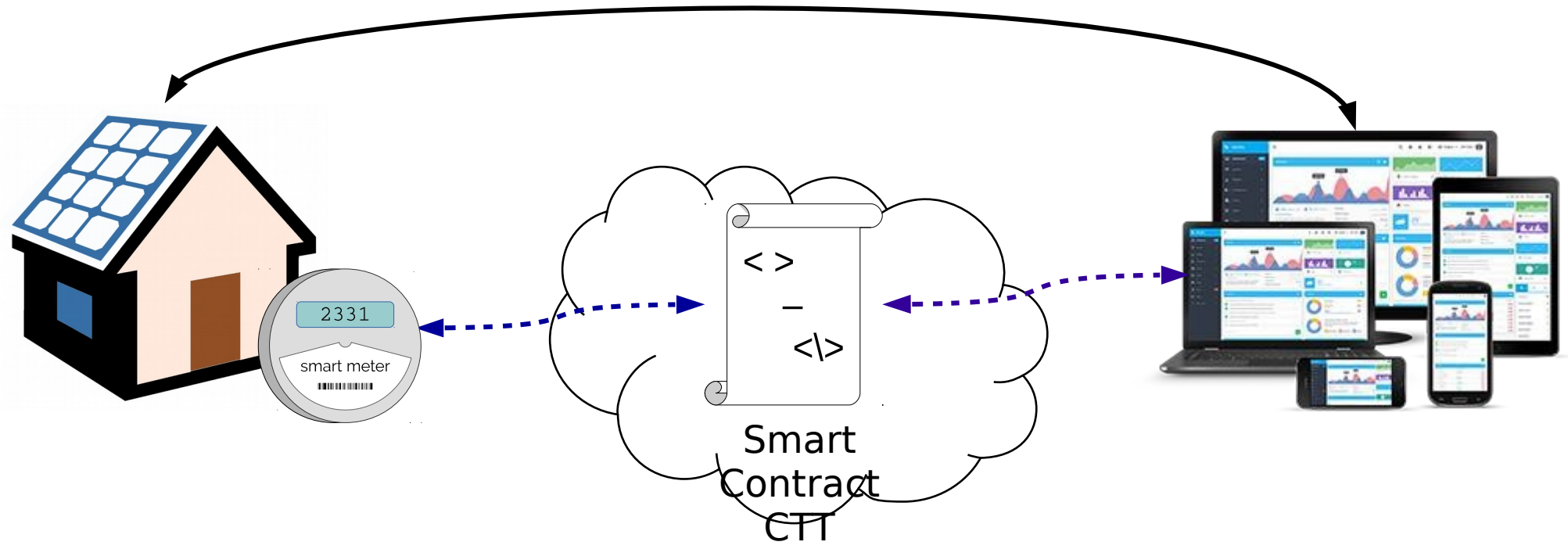
# C-T system overview



# CTT System Design



# Objective: Crypto-Trading Token trade



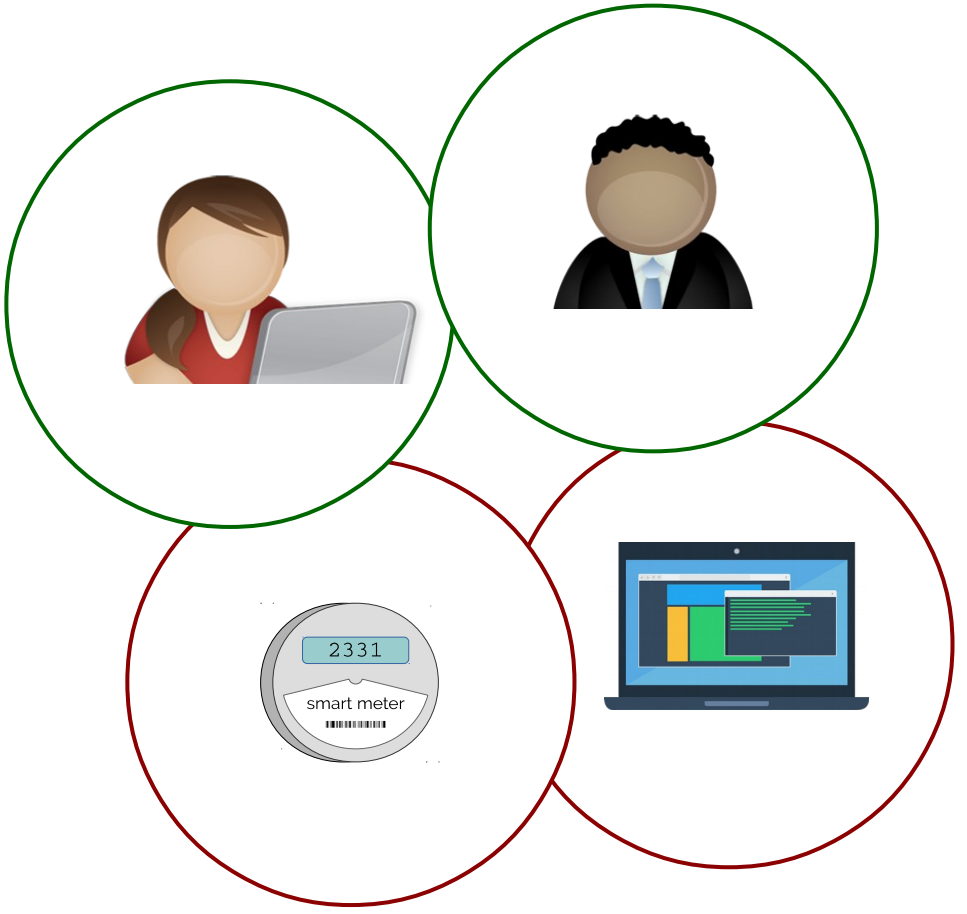
# Actors

System Admin

Prosumer

Smart Meter

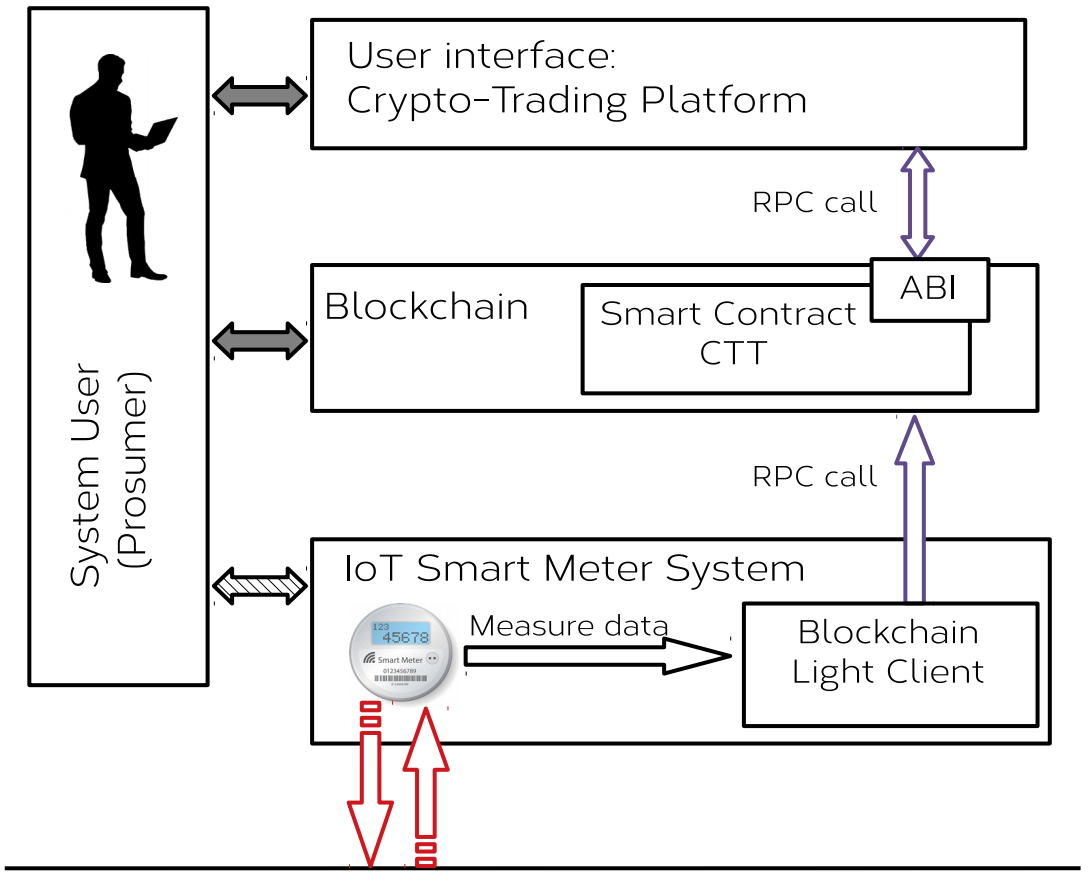
Trading Platform



# User Stories

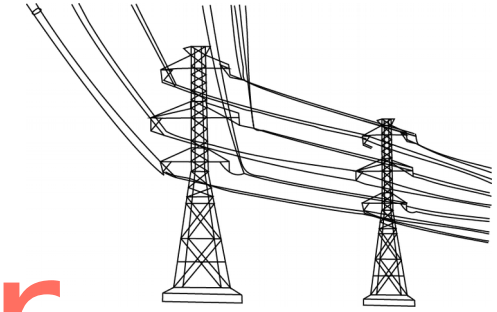
| U.S. | Name | Actors |
|---|---|---|
| CRC | Create CTT | System admin |
| USA | Update System Admin | System Admin |
| STS | Set Token max supply | System Admin |
| STC | Set Token capability | System Admin |
| ST | Sell Token | Prosumer,Trading Platform |
| BT | Buy Token | Prosumer,Trading Platform |
| ASM | Authorize Smart Meter | Prosumer, Smart meter |
| CEA | Consume Energy Amount | Smart Meter, |

# C-T architecture



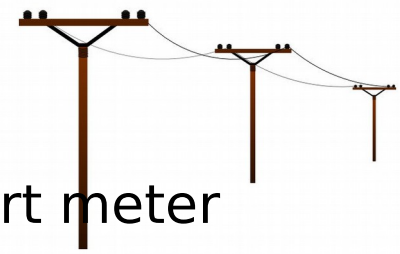
# The System in detail

# The role of the Service Operator



Service Operators DSO and TSO are responsible to

- distribute the energy through the network;
- provide or certify smart meters to prosumer
- measure energy produced by each prosumer and injected into the power network;
- measure energy consumption by each consumer
- request payments for energy consumption and for smart meter



# The rechargeable token

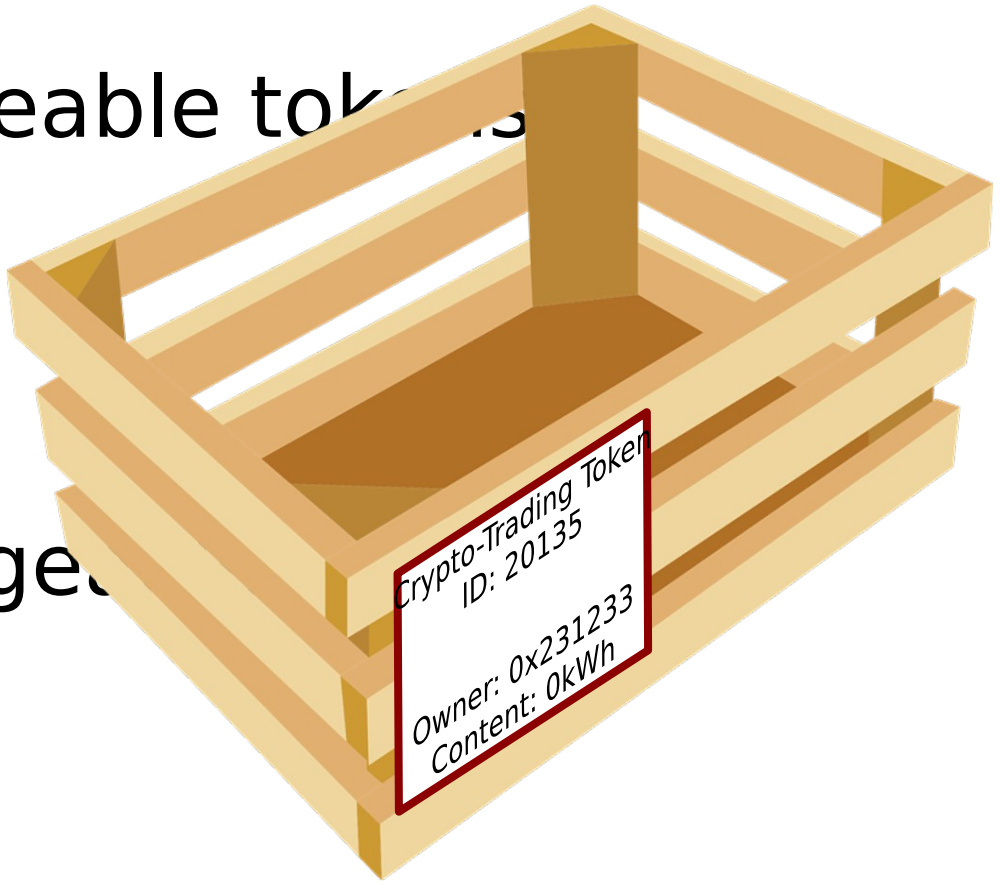
Limited in number tradeable tok

Created empty

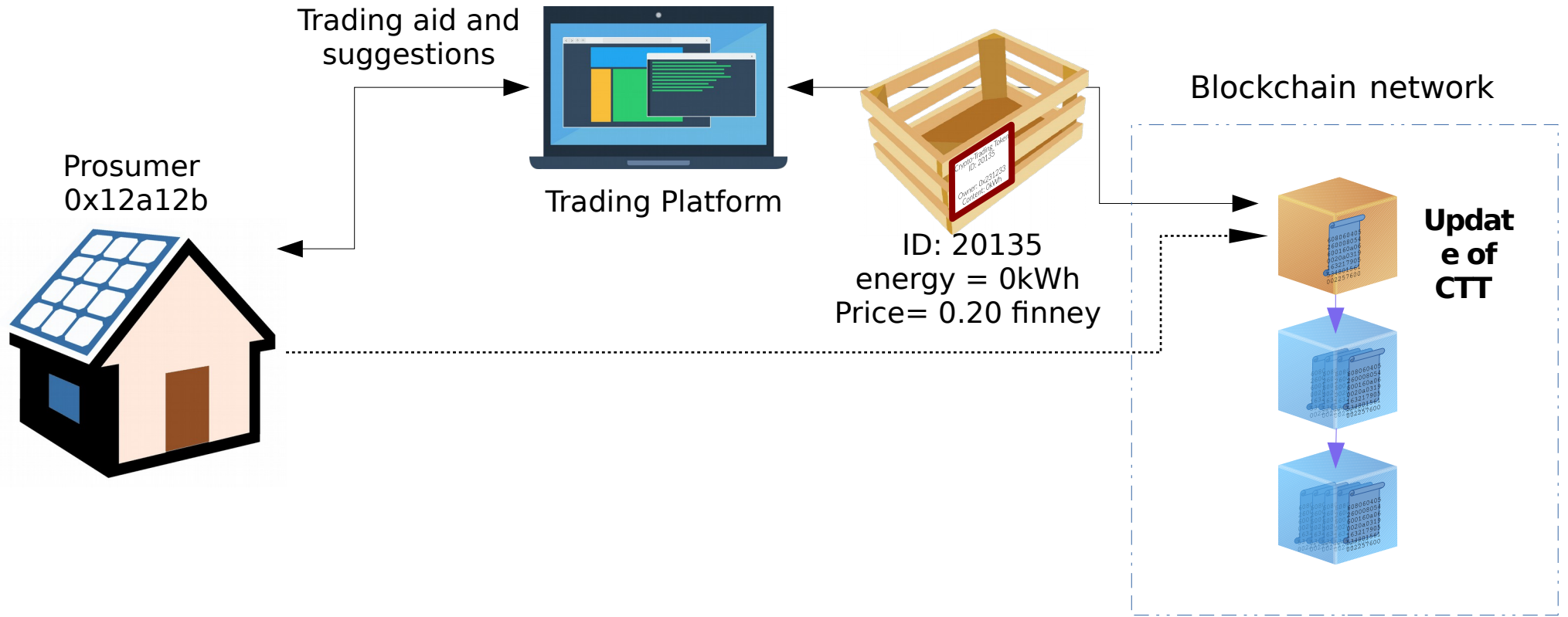
Buyable empty or full

Depletable and Recharge

Resalable

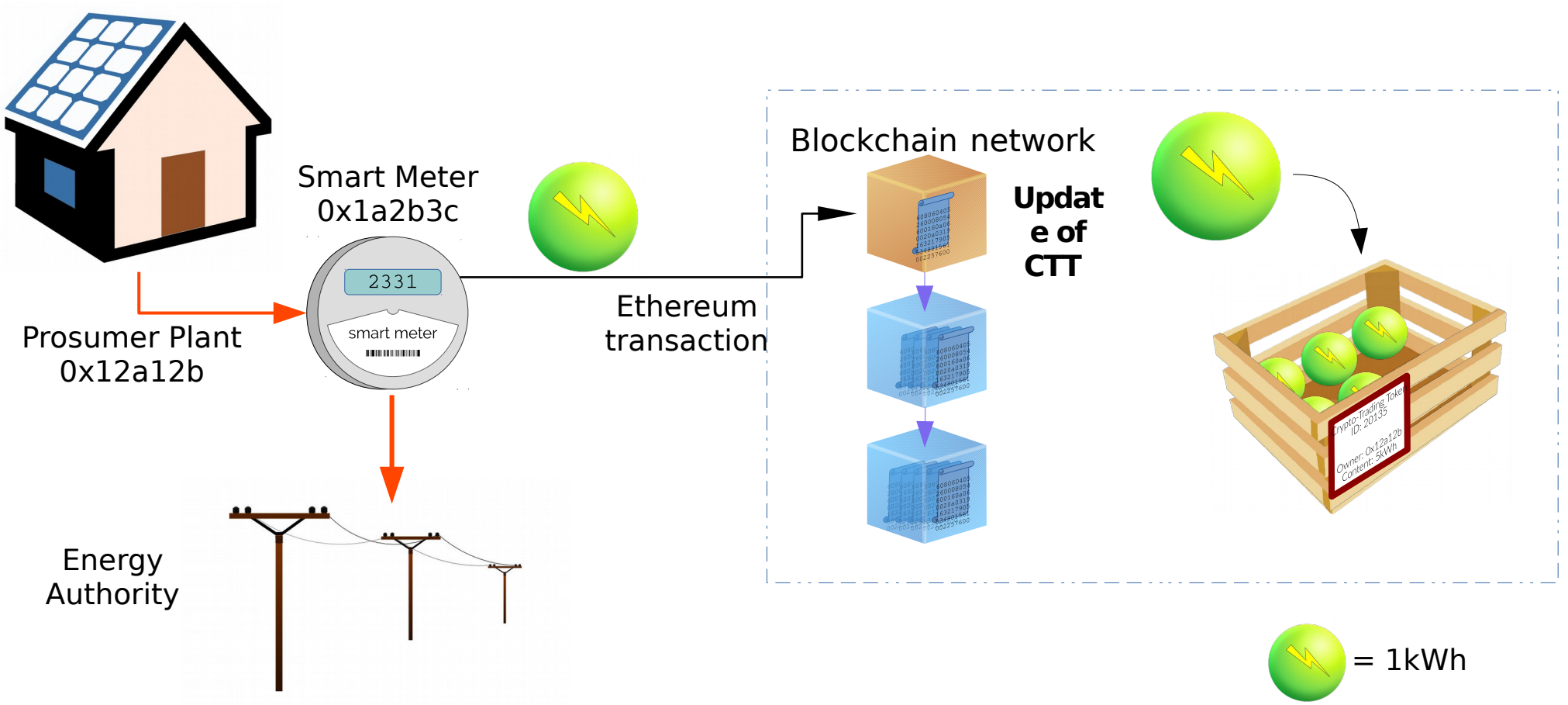


# Purchase Token




1 ether= 1000 finney

# Production Phase



# Token sales

Trading aid and suggestions

Ethereum transaction

Blockchain network

Prosumer
0x12a12b

Trading platform

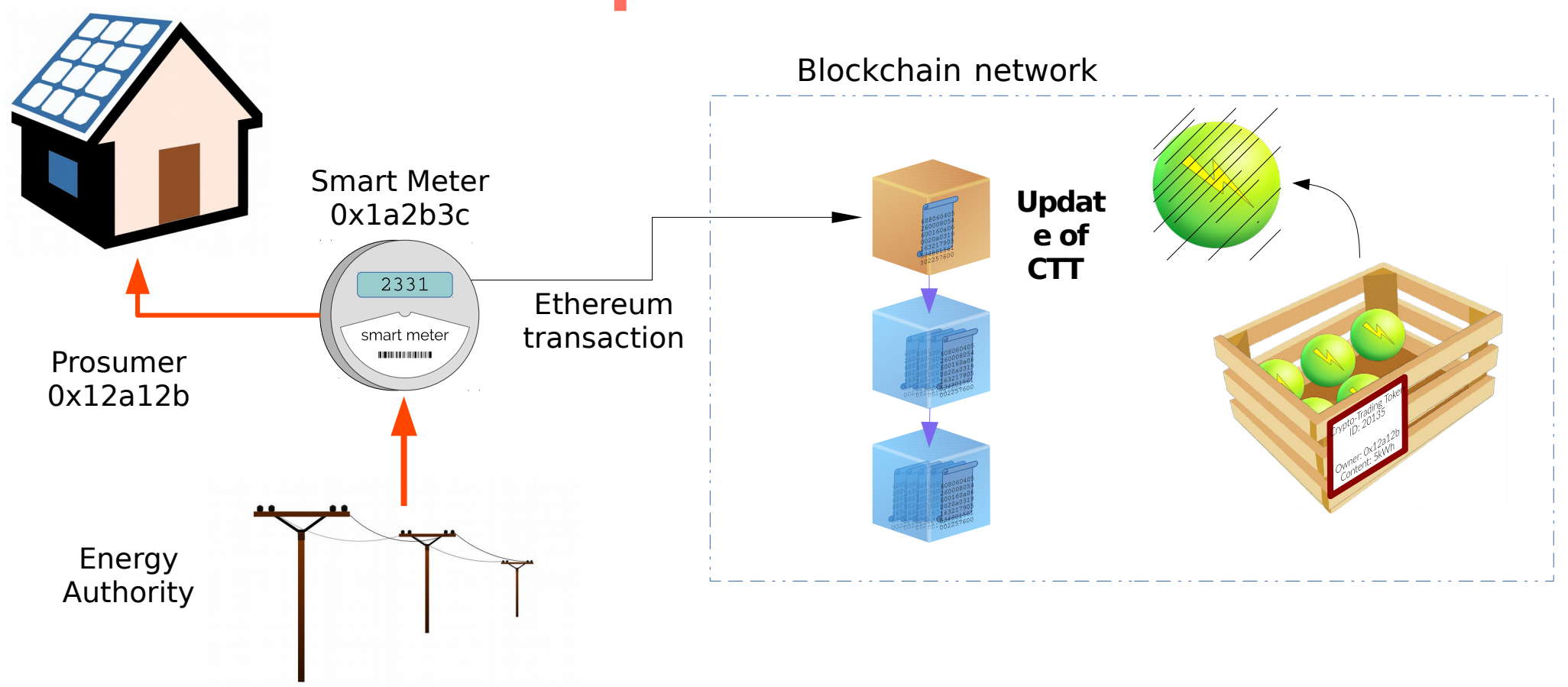
Updat e of CTT

1. Set token price = 0.25 finney
2. Set energy price = 0.20 finney/kWh
Final Token Price = 1.45 finney

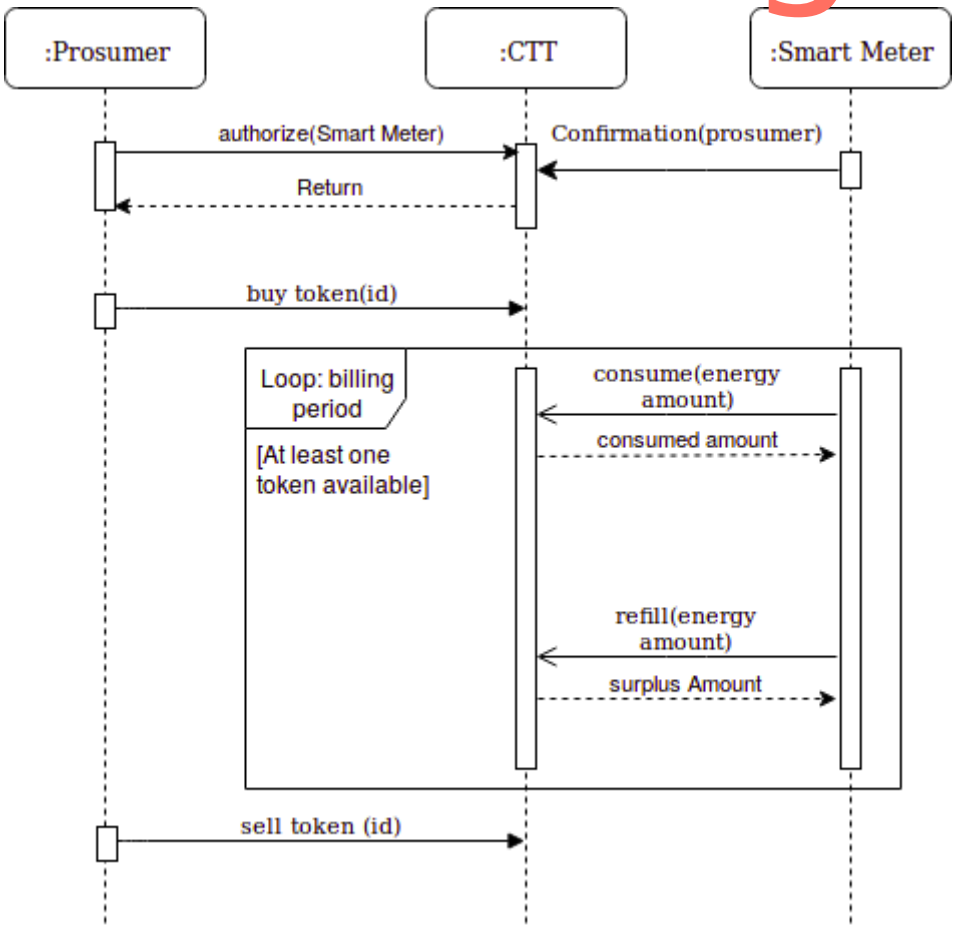
ID: 20135
Energy = 6kWh

1 ether= 1000 finn

# Consumption Phase



# Sequence diagram



# YOUR ELECTRICITY BILL

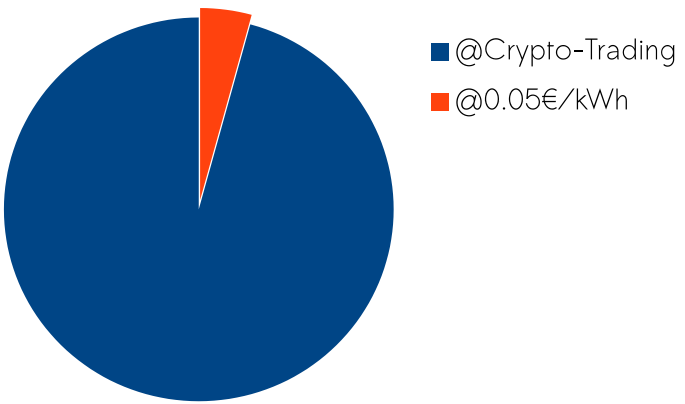
ABC Company

| | |
|---|---|
| Account Name | Mr. John Smith |
| Account Number | 0231-1222 |
| Crypto-Trading Address | 0x12a12b |

**Bill Period:** 3 Jul 2019 to 3 Aug 2019

## Your Electricity Charges

| | |
|---|---|
| Total Electricity consumption | 355.13 kWh |
| **Electricity** | |
| 340.00 kWh **@ Crypto-Trading** | 0.00 |
| 15.13 kWh @ 0.05€/kWh | 0.7565 |
| Delivery | 25.00 |



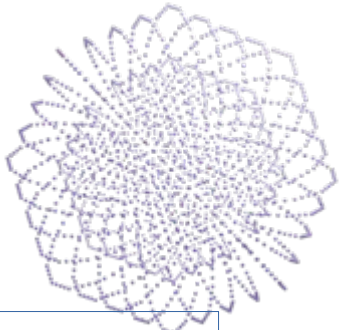

| | |
|---|---|
| Your Total Electricity charges | 25.7565 |
| **Other Charges** | |
| **Meterer Rental** 0x1a2b3c | 5.00 |
| **Discount** | -0.0065 |
| **Total Due** | 30.75 |

# Implementation

# CTT smart contract

- Solidity Smart contract
- ERC721  compliant
- Energy-Web network
- Tobalaba test-net

# Token features



ERC-721

```
contract CTT is ERC721 {

    uint public lastTokenId; // Id of the last minted token
    address payable public admin; //Address of the
                                  //contract's creator
    mapping(uint => EnergyToken) public _tokens;
    mapping(address => Prosumer) public _prosumers;


  ...
  ...
}
```

# Token supply

MaxTokenSupply = Maximum number of Energy Tokens (MET)
EnergyCapacity = Capacity of each Energy Token (CET) in kWh

Total Energy Supply (TES) = MET x CET.

Given CET= 10kWh and TES = 1TWh → MET= $100 \times 10^6$ tokens

# CTT structure (1)

```
struct EnergyToken {
       uint tokenPrice; // must be expressed in ether;
       uint energyPrice;
       uint energyAmount; // How much energy is stored in a token;
                          // default: 10 KWh
       bool onSale; // is token on sale; default: false
   }
```

Selling Price = Token Price + (Energy Amount x Energy Price ).

# CTT structure (2)

```
struct Prosumer {
      // Tokens owned by a prosumer (array of tokens' id)
       uint[] tokensOwned;
      // tokenId x owned by prosumer is in position y
       mapping(uint => uint) indexes;
       // Address of the smart meter associated to a prosumer
       address smartMeter;
      // Tells if the prosumer is confirmed as a platform user;
default: false
       bool confirmed;
   }
```

# CTT functions

| Function | Type | Parameters | Modifier | User Story |
|---|---|---|---|---|
| setMaxTokenSupply | Public | maxSupply:uint | onlyOwner | STS |
| setTokenCapability | Public | capability:uint | OSMP | STC |
| consume | External | maxAmount:uint;<br>prosumer:address | OSMP | CEA |
| refill/recharge | External | amount:uint;<br>prosumer:address | OSMP | REA |
| register | Public | smartMeter:address | | ASM |
| confirm | Public | prosumer:address | OSMP | ASM |
| buyEmptyToken | Public Payable | | | BT |
| setOnSale | Public | tokenID:uint | | BT |

# CTT Network

*“open-source, scalable blockchain platform specifically designed for the energy sectors regulatory, operational, and market needs”*

Energy web Foundation

- Proof-of-Authority
- Affiliation required
- Tobalaba testnet: 3 blocks/sec

energy web

# Projects comparison

| Feature | Crypto-Trading | Etherchain | Exergy | Power Ledger |
|---|---|---|---|---|
| **Blockchain** | Ethereum<br>Energy Web | Tendermint Wormhole | Exergy | Ethereum |
| **Consensum** | Proof-of-Authority | Byzantine fault tolerant | Proof-of-Ownership | Proof-of-Stake |
| **Policy** | Public | Permissioned | Private | Private and Public |
| **Token** | CTT (non- fungible ERC721 token) | EnerCoin | Exergy | Power (ERC20)<br>Sparks (ERC20) |
| **Token aim** | Marketable token and rechargeable energy account | Purchasable Euro based token for energy exchange | Function enabler<br>Purchasable token | Power: marketable token;<br>Sparks: marketable energy quantum |
| **Trading functions** | AI aided energy and token trading | Openbazar bazed market | Transactive market and adaptive price formation | Double trading system (application host platform to trde sparks) |
| **Business Model** | Token selling | Transaction fees or subscription fee | Token Pre-selling | Token selling |

# Conclusions

Crypto-Trading is a system designed to exploit the blockchain technology for supporting trading in the energy market by means a trading platform.

Include the use of smart meters which represent the subsystem which is connected both the internet and to the energy network. It periodically or on demand, sends data about energy production and consumption to the blockchain subsystem and to the Service Operator.

The blockchain subsystem is based on newly designed rechargeable energy token, which exploits and extends the Ethereum ERC721 token. In particular, each Crypto-Trading Token contains an energy amount that can be recharged by means a local energy production, or consumed to save money.

The blockchain subsystem is conceived to run on the Ethereum based Energy-Web platform, specifically designed for the energy sector.